Exploration Systems Mission Directorate

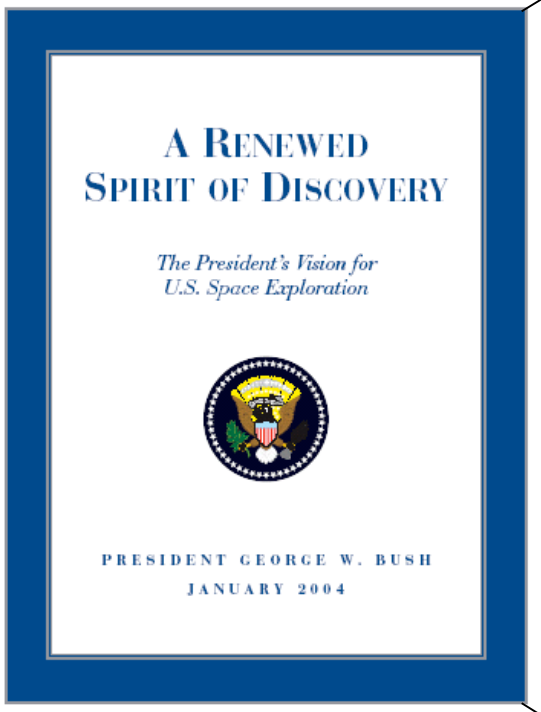
The Vision for Space Exploration

Biological Effects of Lunar Dust Workshop
Sunnyvale, CA

Dr. Terri L. Lomax
Deputy Associate Administrator for Research
March 29, 2005

The Vision for Space Exploration

THE FUNDAMENTAL GOAL OF THIS VISION IS TO ADVANCE U.S. SCIENTIFIC, SECURITY, AND ECONOMIC INTEREST THROUGH A ROBUST SPACE EXPLORATION PROGRAM



Implement a sustained and affordable human and robotic program to explore the solar system and beyond

Extend human presence across the solar system, starting with a human return to the Moon by the year 2020, in preparation for human exploration of Mars and other destinations;

Develop the innovative technologies, knowledge, and infrastructures both to explore and to support decisions about the destinations for human exploration; and

Promote international and commercial participation in exploration to further U.S. scientific, security, and economic interests.

Vision for Space Exploration

Key Presidential Direction

1. *Return the Shuttle to safe flight as soon as practical, based on CAIB recommendations*
2. *Use Shuttle to complete ISS assembly*
3. Retire the Shuttle after assembly complete (2010 target)
4. *Focus ISS research to support exploration goals; understanding space environment and countermeasures*
5. Meet foreign commitments
6. *Undertake lunar exploration to support sustained human and robotic exploration of Mars and beyond*
7. *Series of robotic missions to Moon by 2008 to prepare for human exploration*
8. *Expedition to lunar surface as early as 2015 but no later than 2020*
9. *Use lunar activities to further science, and test approaches (including lunar resources) for exploration to Mars & beyond*
10. *Conduct robotic exploration of Mars to prepare for future expedition*
11. *Conduct robotic exploration across solar system to search for life, understand history of universe, search for resources*
12. *Conduct advanced telescope searches for habitable environments around other stars*
13. *Demonstrate power, propulsion, life support capabilities for long duration, more distant human and robotic missions*
14. *Conduct human expeditions to Mars after acquiring adequate knowledge and capability demonstrations*
15. *Develop a new Crew Exploration Vehicle; flight test before end of decade; human exploration capability by 2014*
16. *Separate cargo from crew as soon as practical to support ISS; acquire crew transport to ISS after Shuttle retirement*
17. *Pursue international participation*
18. *Pursue commercial opportunity for transportation and other services*

New Way of Doing Business

Spiral Development

- Focused on System-of-Systems

Strategy-to-Task-to-Technology Process

- Requirements-driven technology investment
- Operational Advisory Group

Innovative acquisition strategies

- Broad Agency Announcement
- Competition/Collaboration
- Government/industry partnerships—RFI/RFP generation
- International participation / Exploration Conferences

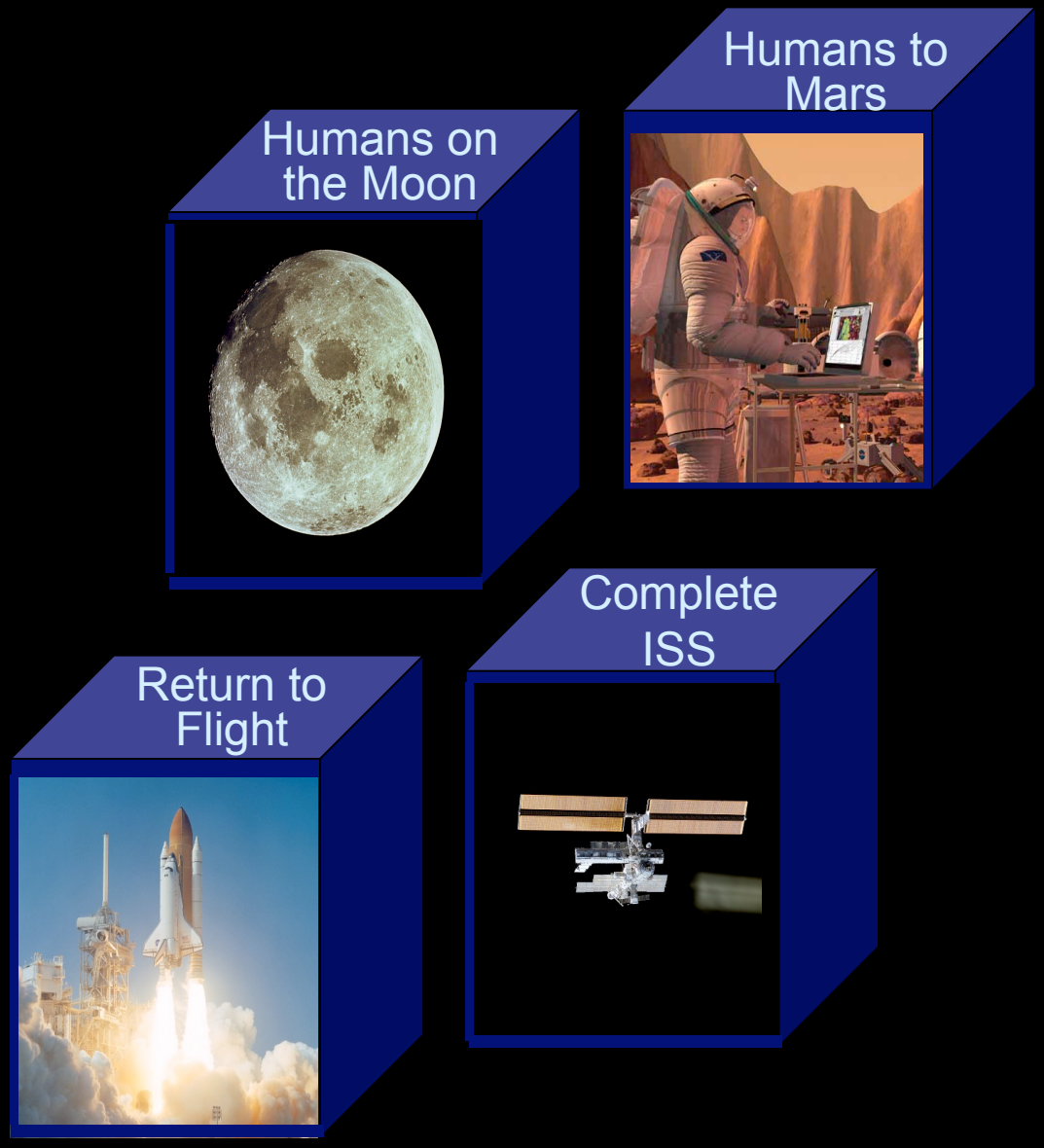
Rigorous acquisition strategy and execution

- Management rigor—"Best of Breed" from NASA / DOD / Industry / Academia
- Integrated Agency approach
- Disciplined / Institutionalized processes—Tools, Program Management Handbook…
- Systems Engineering & Integration

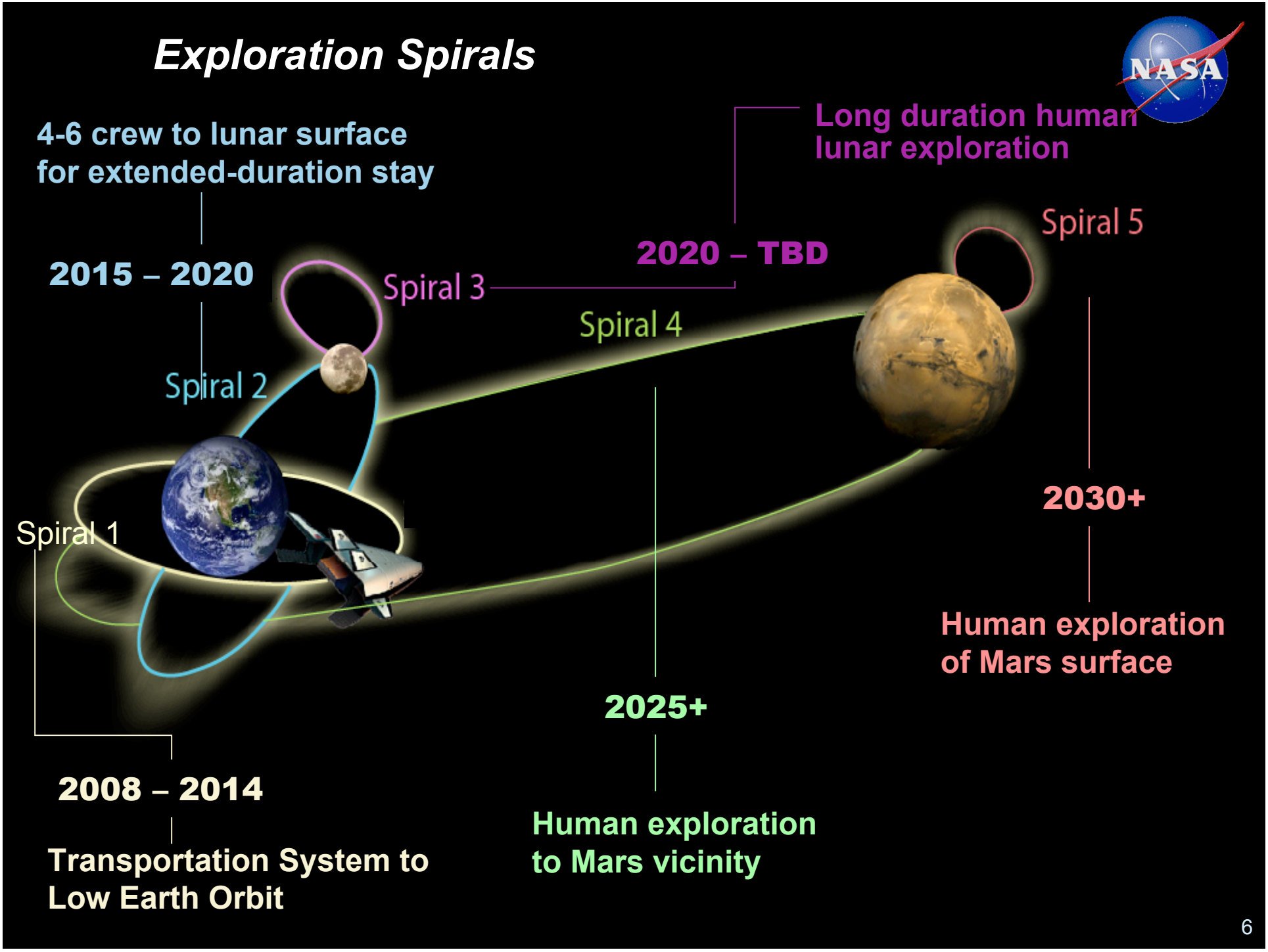
Inspire

- Educate, Excite, Recruit…

Building Block Approach



Exploration Spirals



Exploration Spirals

- **Spiral 1 (2008-2014)**
  - A transportation system for human space flight into low Earth orbit no later than 2014
  - Lunar robotic exploration
- **Spiral 2 (2015-2020)**
  - Extended duration human lunar exploration as early as 2015, but no later than the year 2020
  - Mars robotic exploration
- **Spiral 3 (2020-TBD)**
  - Long-duration human lunar exploration
  - Mars robotic exploration
- **Spiral 4 (~2025-TBD)**
  - Human exploration missions to the vicinity of Mars
- **Spiral 5 (~2030-TBD)**
  - Initial human Mars surface exploration missions

System-of-Systems Integration

Transit and Launch Systems

Crew Transport

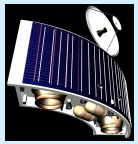
Launch

Crew Support

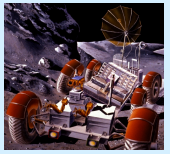
The Human: an Essential Element of the System of Systems

Surface and Orbital Systems

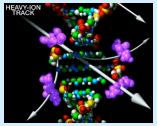
Landing Systems

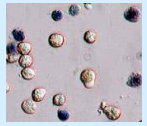


Comm/Nav

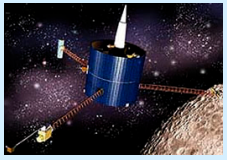


Surface Mobility





Biomedical Countermeasures and Limits



Resource Identification and Characterization

Supporting Research

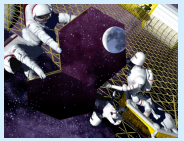
Long-Duration Habitation

Pre-Positioned Propellants

Surface Power and Resource Utilization

Technology Options

Mars Candidates

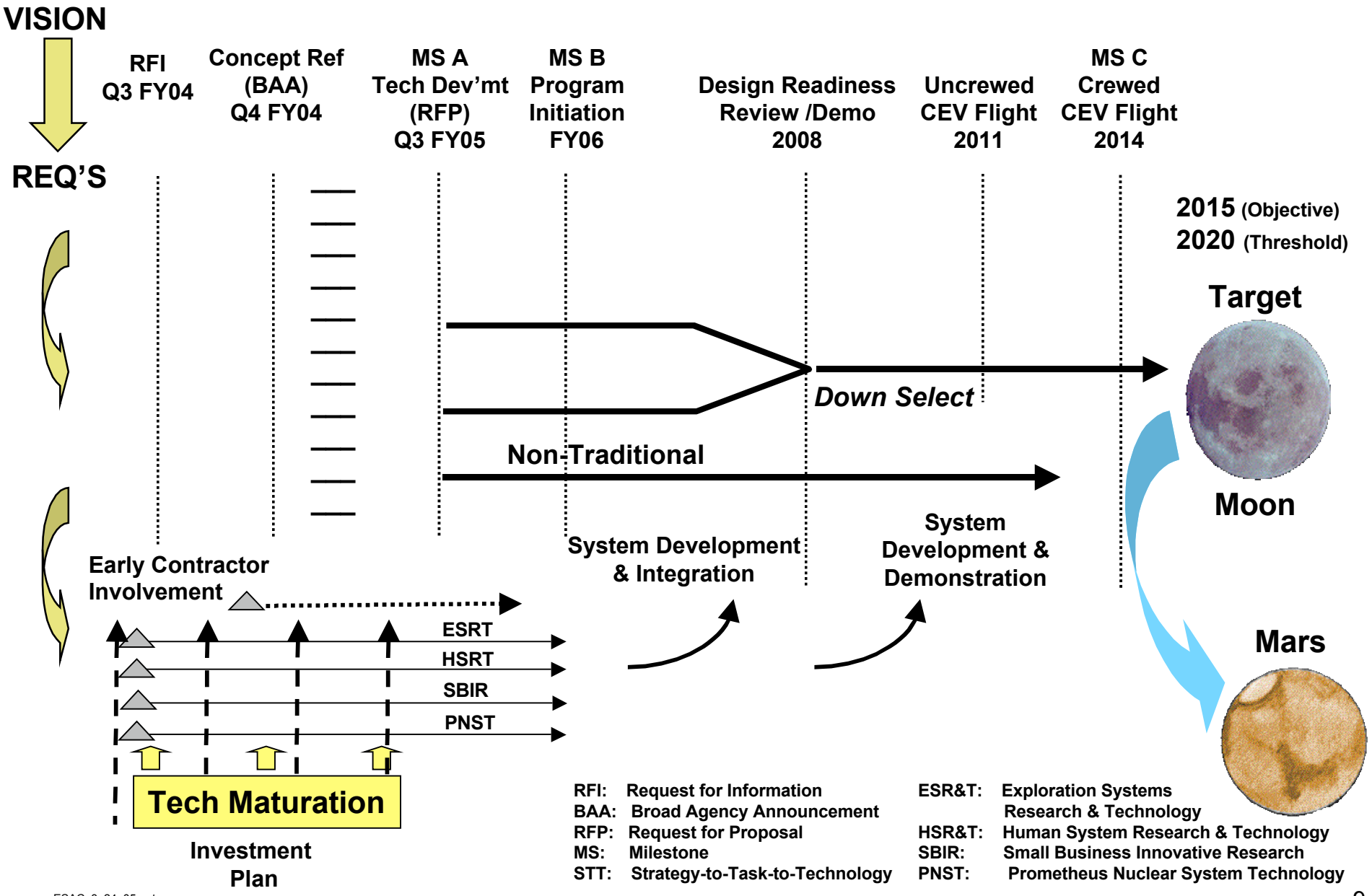


Telescope Candidates

Outer Moons Candidates

Commonality/Evolvability For Future Missions

Strategy Overview (Baseline)



RFI: Request for Information
BAA: Broad Agency Announcement
RFP: Request for Proposal
MS: Milestone
STT: Strategy-to-Task-to-Technology

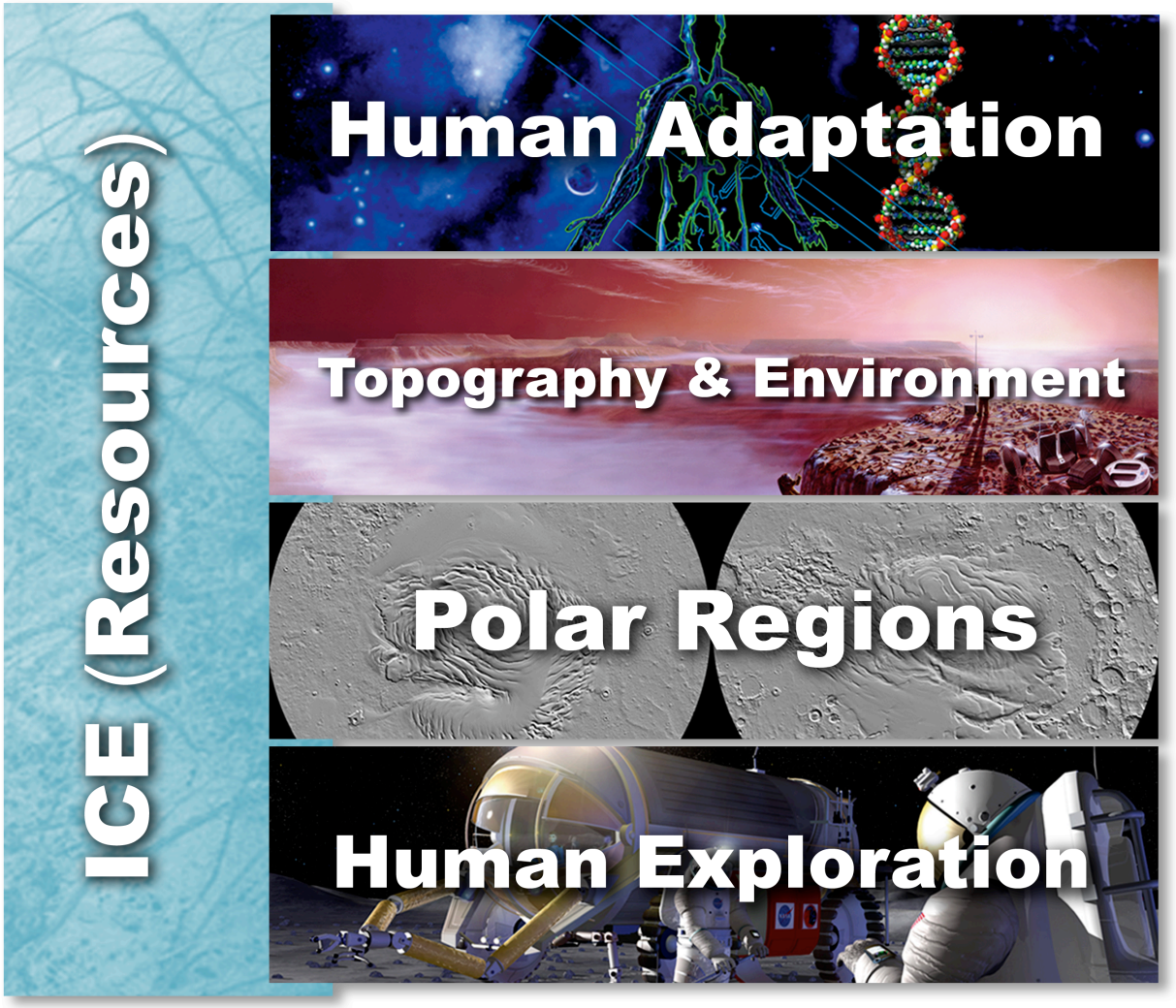
ESR&T: Exploration Systems Research & Technology
HSR&T: Human System Research & Technology
SBIR: Small Business Innovative Research
PNST: Prometheus Nuclear System Technology

Preparing for Mars Exploration

Moon as a test bed to reduce risk for future human Mars missions

- **Technology advancement** reduces mission costs and supports expanded human exploration
- **Systems testing** and technology test beds to develop reliability in harsh environments.
- **Expand mission and science surface operations** experience and techniques
- **Human and machine collaboration**: Machines serve as an extension of human explorers, together achieving more than either can do alone
- **Breaking the bonds of dependence on Earth**: (e.g./Life Science/Closed loop life support tests)
- **Power generation and propulsion** development and testing
- **Common investments** in hardware systems for Moon, Mars and other space objectives

'08 Lunar Robotic Orbiter (LRO) Measurements Strategy: Prepare for Human Exploration

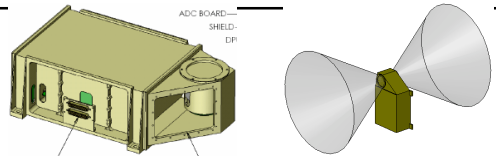
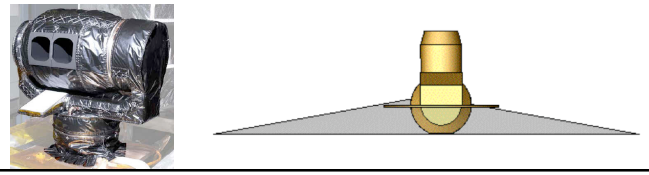
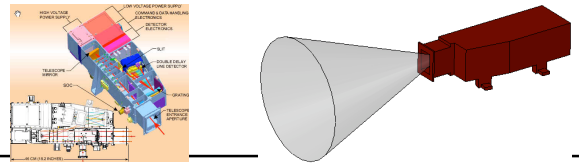
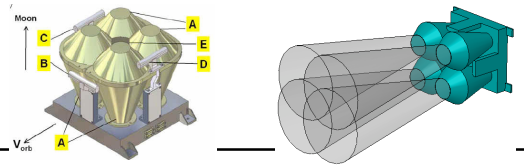
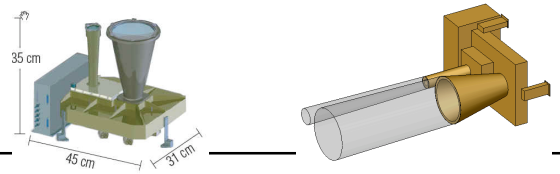
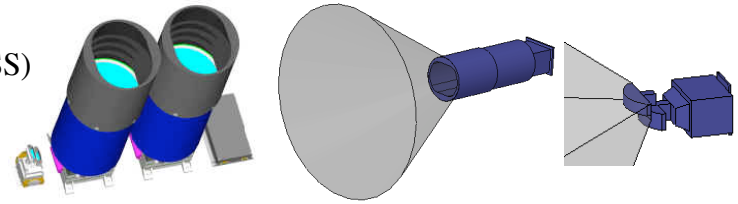


Where • When • Form • Amount

Project Objectives

- Biological adaptation to lunar environment (radiation, reduced g, dust…)
- Understand the current state and evolution of the volatiles (ice) and other resources in context
- Develop an understanding of the Moon in support of human exploration (hazards, topography, navigation, environs)

Competitively Selected LRO Instruments Provide Broad Benefits

INSTRUMENT	Benefit	Deliverables
CRaTER (BU+MIT) 	**Shielding constraints**	***Tissue equivalent response to radiation***
Diviner (UCLA) 	**Surface temperatures**	***300m scale maps of Temperature, surface ice, rocks***
LAMP (SWRI) 	**Frosts? "atmosphere"?**	***Maps of frosts in permanently shadowed areas, etc.***
LEND (Russia) 	**Ice in regolith down to 1 m ?**	***Maps of water ice in upper 1 m of Moon at 5km scales***
LOLA (GSFC) 	**Precision, safe navigation (3D)**	***~50 m scale polar topography at < 1 m vertical, roughness***
LROC (NWU+MSSS) 	**Landing hazards and some resources**	***1000's of 50cm/pixel images (125km^2), and entire Moon at 100m in UV, Visible***

Exploration Biomedical Issues

- **Robust life support and habitation**
- **Radiation protection (galactic cosmic and solar events)**
- **Communication delays (up to 40 minutes to Mars) and/or long periods without communication**
- **Limited or no ability to return to Earth for contingencies**
- **Autonomous clinical care**
  - Physician CMO
- **Psychosocial, behavior and performance issues**
- **Improved therapeutics**
  - Wound care, non-invasive treatment capabilities
  - Surgical support
- **Increased diagnostic capabilities**
  - Lab analysis, critical care monitor, ultrasound
- **Integrated micro-g and low-g diagnostic/ treatment protocols**
- **Medical consumables**
  - Pharmaceuticals, IV fluids, dressings, etc.
- **Dust mitigation??**

Exploration Systems Mission Directorate

We're not where we want to be,
We're not where we're going to be,
<u>BUT</u> we're certainly not where we were yesterday.